

THE INTEGRAL ROLE OF BOROUGH OF MANHATTAN COMMUNITY COLLEGE IN THE MATHEMATICS PREPARATION OF PROSPECTIVE TEACHERS

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Borough of Manhattan Community College (BMCC) of the City University of New York (CUNY) is the only two-year college on the island of Manhattan. This institution has a diverse population of approximately 17,000 students who attend day/evening/weekend classes. Over 1,000 students are enrolled in the Early Childhood Education (ECE) Program. Each year, approximately 300 new students select this area of concentration. The dropout rate is less than 14%. The ECE Program prepares students for elementary education programs at four-year institutions. The program also offers two career areas of study: Infant Toddler and Pre-School.

This article will discuss how high quality teacher preparation at BMCC is promoted through mathematics coursework recommended by the NCTM and AMATYC for prospective elementary school teachers, the importance of technology in providing enriching pre-teaching experiences, collaboration with four-year institutions in teacher preparation efforts, and the importance of special teacher preparation of underrepresented populations for underrepresented populations of New York City.

Borough of Manhattan Community College (BMCC) of the City University of New York (CUNY) is the only two-year college on the island of Manhattan. There are approximately 17,000 students who attend day/evening/weekend classes. Many BMCC students are the first in their families to attend college. Over 90% are non-white; 65% are female; and approximately 75% of entrants require some form of remediation in mathematics. The average student is 21 years of age [1]. Many dialects of various world languages are spoken by the diverse student population.

Over 1,000 students are enrolled in the Early Childhood Education (ECE) Program. Each year, approximately 300 new students select this area of concentration. The dropout rate is less than 14%. In addition to preparing students for elementary education programs at four-year institutions, the ECE Program offers two career areas of study: Infant Toddler and Pre-School. Students may thus choose to work directly with children in elementary/early childhood education settings that include infant care, Head Start Centers, pre-kindergarten, kindergarten, elementary schools, day care, and hospitals for the physically handicapped and

learning disabled. Opportunities also exist for students to work for educational and commercial television. Students interested in the marketing field may use their ECE knowledge in sales and buying of such products as toys, children's books and materials, and children's clothing.

This article will discuss how high quality teacher preparation at BMCC is promoted through mathematics coursework recommended by the NCTM and AMATYC for prospective elementary school teachers, the importance of technology in providing enriching pre-teaching experiences, collaboration with four-year institutions in teacher preparation efforts, and the importance of special teacher preparation of underrepresented populations for underrepresented populations of New York City.

Promoting High-Quality Teacher Preparation through Mathematics Coursework Recommended by the NCTM and AMATYC

Mathematics for Elementary Education I (MAT 114) is a four-credit course that covers mathematics recommended by the National Council of Teachers of Mathematics (NCTM) and the American Mathematical Association of Two-Year Colleges (AMATYC) for prospective elementary school teachers. The course topics include sets, problem solving, logic, numeration, real numbers, and number theory. MAT 114 focuses on a learner-oriented approach to teaching mathematics. Emphasis is placed on mathematical concepts and skills, as well as techniques of inquiry and critical thinking. The course includes a survey of elementary mathematical concepts with appropriate materials to assist teachers in the classroom setting. MAT 114 meets the mathematics requirement only for students in the Early Childhood Education (ECE) Program. Students taking this course must have passed or been exempt from Basic Arithmetic and Elementary Algebra, and all remedial reading, writing and ESL requirements. The BMCC Mathematics Department currently offers three sections of this course each semester, providing for enrollment of approximately 75 students.

In accord with the NCTM standards [2] and the AMATYC standards [3], the course objectives are intended to promote student mastery of both mathematics content and mathematics pedagogy:

Mathematics Content:

- To develop knowledge of sets, problem solving, logic, numeration, real numbers, and

number theory from a higher viewpoint for students who intend to teach in elementary schools;

- To develop the power to communicate mathematically through reading, writing, and discussing ideas which require the appropriate use of the language of mathematics.

Mathematics Pedagogy:

- To be able to plan and utilize the most suitable approach (individualized instruction, cooperative learning, writing activities, etc.) for each type of lesson;
- To know how to determine which topics are best taught in small and which in large group lessons, how to develop challenging assignments, how to create an effective learning environment, ways to allow students to have time to reflect, how to promote student discourse, how to make connections with other branches of mathematics or other subject areas, and how to improve student attitudes toward mathematics;
- To consider alternative approaches in problem solving, the use of calculators and computers, and activities that promote students learning to value mathematics while developing confidence in their own mathematical ability;
- To undertake the initial steps toward professional development through self evaluation and peer interaction;
- To be cognizant of the most recent research and professional consensus about elementary mathematics education, and develop an inquiry-oriented and reflective attitude to the teaching process.

Because the population of students enrolled in this course has had little or no exposure to the type of teaching and learning recommended by the NCTM, one of the required texts for the course focuses on appropriate mathematics pedagogy and use of technology, *Mathematics, A Good Beginning (Fifth Edition)* by Troutman and Lichtenberg. To reinforce and extend college-level mathematics concepts and skills, the content textbook for the course is *Mathematical Ideas (Seventh Edition)* by Miller, Heeren, and Hornsby. Because few of the students can afford to purchase both textbooks, the computerized version of the content textbook, complete with tutorials, is utilized in a Math Lab setting.

Reflecting National Mathematics and Science Standards and Providing Enriching Pre-Teaching Experiences

What makes this course innovative is that the mathematics content and pedagogy are

integrated with technology. Students learn individually or as part of a cooperative group by working with actual manipulative materials, or with electronic materials that are a part of a mathematics software program. Such a format allows prospective elementary school teachers to learn mathematics and mathematical pedagogy in a way they have not been exposed to previously, a way that is consistent with the NCTM's *Standards*. The materials include attribute pieces, Cuisenaire rods, counters, base ten blocks, coins, scissors, paper clips, and rubber bands. The computerized version of *Mathematical Ideas (Seventh Edition)* is utilized during sessions scheduled each week in a Math Lab; this text version is also available for student use during "open" lab periods. Technology (elementary-level mathematics software, college-level mathematics software, and a variety of calculators) is therefore used not only to facilitate learning, review and practice but also to broaden the conceptual and procedural understanding that is crucial for effective pedagogy. Students are also assigned research projects that, for example, require them to obtain certain information about teaching mathematics from various World Wide Web sites or to present and videotape mathematics mini-lessons with small groups of children. Prospective teachers can thus begin their careers with increased awareness of the potential uses of technology through such courses as MAT 114. These courses incorporate a wide range of experiences in the educational uses of technology and set general expectations for prospective teachers to judiciously use technology in their future teaching jobs.

MAT 114 students learn that mathematics is not a spectator sport, but a participatory one. They are expected to help each other both individually and collaboratively in small groups. Classroom discourse is encouraged to help students clarify mathematical ideas and develop abilities to communicate effectively using the language of mathematics. Both the NCTM and the AMATYC *Standards* advocate the use of activities that provide opportunities for students to learn by working in groups and by reading, writing and speaking to enhance mathematical communication skills. MAT 114 students are appropriately provided such experiences and also encouraged to adopt comparable activities in their own future classrooms.

The variety of materials used as embodiments of mathematical ideas facilitate the learning of those ideas in the MAT 114 classroom. Students use manipulatives that help to enhance their understanding and develop their abilities to construct mathematical knowledge. Appropriate materials are also used to emphasize that learning is unique to the learner, and

to show that multiple approaches to the same concept can enrich the classroom environment for every student. For example, a lesson that begins on an elementary level with individual and small group activities involving playful examination and sorting/classifying of attribute pieces or pattern blocks develops to incorporate college level concepts of set theory and logic. Cuisenaire rods, counters, and base ten blocks are used in later activities to review numeration systems and introduce college level concepts related to finite mathematical systems.

Thus, mathematical ideas needed for the development of an elementary school topic are introduced and developed using suitable concrete and/or pictorial models. This allows MAT 114 students to (re)learn the mathematics in a non-threatening manner, and helps them make appropriate connections between the elementary and college level content. MAT 114 students also grow to appreciate the connection between content and pedagogy that facilitates teaching with expertise and clarity. The prospective teachers are gradually introduced to materials that will benefit elementary school students when learning mathematics. The textbooks that emphasize the teaching/learning of elementary-level mathematics and college-level mathematics help put the activities into perspective. They provide background readings on pedagogical issues and various ways children learn mathematics; they include the construction of lessons, activities and exercises to extend pedagogical experiences and content knowledge. To emphasize that mathematics is not limited to the physical boundaries of the classroom, students are asked to complete a variety of written projects such as publications research, teacher interviews, technological investigations, and conference reports. Prospective teachers must see the relevance of mathematics to help uncover it for their students. The projects provide opportunities for exploring the mathematics taught throughout the grades, sequencing within mathematical topics, comparing approaches used in various textbooks, and reviewing mathematical content. Reading professional mathematics journals such as *The Arithmetic Teacher* and *Teaching Children Mathematics*, evaluating software for elementary students, locating and collecting information from appropriate web sites - and sharing or presenting information for class discussions - are important for professional growth. These activities enable the prospective teacher to put mathematical ideas into the context of the classroom, reinforce that there is no one right way to teach mathematics, and allow for a continuation of dialogue of mathematical ideas and teaching strategies.

The role of the instructor varies throughout the MAT 114 course. At times the instructor

acts as a facilitator, posing open-ended questions, helping students answer their own questions, and generally encouraging the dialogue and investigation of mathematical ideas that characterize the excitement of learning mathematics. Sometimes the instructor might lecture, encourage cooperative problem-solving activities, or help summarize and/or generalize some of the ideas that were considered during the class. The aim is to model effective teaching that promotes mastery of both mathematics content and pedagogy. As parents of New York City public school children or as graduates of inner city schools, MAT 114 students are (re)constructing course content in unique ways that reflect increasing understanding of both content and pedagogy.

Collaborating with Four-Year Institutions in Their Teacher Preparation Efforts

The three former pre-college level educators who teach MAT 114 are actively involved in many organizations advocating the reform of school mathematics and programs for prospective teachers. One such group, the NSF-funded New York Collaborative for Excellence in Teacher Preparation in Mathematics, Science and Technology, meets regularly each semester and promotes articulation of mathematics and science courses offered by two-year and four-year colleges. Among the institutions included in the collaborative are New York University (NYU) and five four-year colleges of the City University of New York (CUNY). Because syllabi, such as those from NYU (E12.002, Mathematics for Decision Making), City College-CUNY (Math 185, Basic Ideas in Mathematics), College of Staten Island-CUNY (Math/SLS 118 Sections 6912/6913, Fundamentals of Mathematics I), Hunter College-CUNY (MAT 104, Math for Elementary School Teachers, Semester I) and BMCC (MAT 114, Math for Elementary Education I) are shared and discussed during meetings of the collaborative, activities and ideas are adopted by both the two-year and four-year colleges, thus promoting higher and more uniform standards of excellence in teacher preparation.

Students who successfully complete the MAT 114 course currently offered at Borough of Manhattan Community College may go on to the next level course if they pursue further study as elementary education majors at Hunter College. Due to changes in mathematics courses offered by four-year institutions that BMCC students eventually attend, MAT 114 has undergone gradual modifications. Initial changes were made to preserve articulation with Hunter's new MAT 104, the first in a neoteric series of three courses taught by both mathematics and education faculty. MAT 104 begins with the integration of probability and

statistics with mathematical pedagogy; this mathematical content is from a course that few of BMCC's graduating ECE students ever take, MAT 115. As other four-year colleges (re)designed their courses to include the pedagogy with varying combinations of the content from MAT 114 and MAT 115, it is now proposed that both courses be required so that BMCC's ECE graduates will be adequately prepared for mathematics courses at any of the four-year institutions.

Further articulation efforts are underway for a new course in Mathematical Reasoning at City College. One member of the City College Mathematics Department and one member of the BMCC Mathematics Department are involved in the development of this course.

Clearly BMCC has benefited from active membership in the New York Collaborative for Excellence in Teacher Preparation in Mathematics, Science and Technology. There is an urgent need for more two-year colleges to participate in such collaboratives to ensure that two-year college students are adequately prepared for four-year college education programs, particularly for courses in mathematics, science and technology.

As each state in the United States aims to revitalize schools to meet 21st century demands, it has become apparent that success depends fundamentally on teachers. Good teachers produce good students. Underprepared teachers of disadvantaged students are less likely to know how children grow, learn, and develop, or about what to do if children are having academic or personal difficulties. Yet statistics indicate that over 50,000 teachers annually have been entering teaching on emergency or temporary certificates with little or no preparation at all [4]. Most of the inexperienced and uncertified teachers in the state of New York are teaching in New York City schools where minority groups constitute a majority of the student population [5].

Many ECE students have attended these schools and been taught by such teachers. Inadequately prepared for college work, these students require remedial classes in reading, writing and/or mathematics before beginning their credit-bearing courses. Some ECE students must complete extensive work in arithmetic and algebra before enrolling in MAT 114. Not surprisingly, the anathema of early educational inequities can lead to even greater challenges in meeting new and more rigorous standards of CUNY teacher preparation programs and New York State Teacher Certification [5].

Poorly prepared teachers promote inequality in opportunities for students to learn and eventually achieve their academic and career goals. This can lead to educational, economic and social stagnation at the very time when all students need to be prepared more effectively for advancement in the highly-technological, global society of the 21st century. Many of BMCC's ECE students have overcome the odds cast against them by underprepared teachers. These students have begun a positive movement that gains momentum through their adequate preparation during the first two years of college for future undergraduate courses. Collaborative efforts of two-year and four-year institutions thus feed the momentum of this positive movement.

National and international assessments, such as the Third International Mathematics and Science Study (TIMSS) [6], indicate that few students are prepared to do the kinds of thinking and problem solving required for college level work in mathematics, science, reading, and writing. Students in the United States score near the bottom of most international comparisons in mathematics and science, especially on such tasks requiring critical thinking and problem-solving skills [6]. Clearly the need for good teachers, particularly those qualified to teach mathematics and science, is crucial. More precisely, the need for such teachers – that BMCC students can become in New York's inner city schools – is paramount.

Focusing on the Active Recruitment of Prospective Teachers from Underrepresented Populations

Because 65% of the BMCC student population are female and 91% are non-white, the majority of the college population is from traditionally underrepresented populations. Statistical analyses of BMCC also show that over 1,000 students are enrolled in the Early Childhood Education Program; each year, approximately 300 new students select this area of concentration in which the dropout rate is less than 14% [7].

During the next two decades the demand for teachers has been predicted to increase substantially due to higher birth rates and immigration. The teaching force has also aged considerably so large numbers of retiring teachers will have to be replaced. In New York City alone, where over fifty percent of the population will be foreign- or Puerto Rican- born, the predicted shortage of public school teachers due to retirements is estimated at 15,000 by the year 2000 [8].

Clearly, teacher preparation is crucial at this time. Statistics indicate that although the demand for new teachers is growing, the supply of newly-prepared teachers dropped sharply for two decades (1970-1989), and is just beginning to increase once again. There was a particularly sharp decline in the number of academically able minorities and women, who shifted from education to business, health professions, law, and other occupations. As these other professions opened up to minorities and women, teaching lost preference. Teaching is now forced to compete with other occupations for talented entrants [1].

Attractions to teaching have improved somewhat because higher salaries are closing the gap between teaching and other occupations. This has also helped increase teacher supply and quality. Obviously, teaching vacancies are being, and will continue to be, filled from other sources. However, attracting and retaining qualified teachers at higher rates will be vital to improving the quality of education, particularly in inner city schools. Reports of the National Center for Education Statistics show that schools with higher minority enrollments have the most difficulty filling vacancies with qualified teachers [9]. To deal with these shortages, principals sometimes hire less qualified teachers, use substitutes, cancel courses, raise class sizes, or ask teachers to teach outside their field of preparation.

Clearly, efforts to raise standardized test scores and graduation requirements in mathematics will be futile if there are not enough teachers prepared to teach the subject well. Students' critical and analytical thinking skills cannot improve significantly without teachers who know how to promote such thinking and without an environment that supports such thinking. Needs of inner-city children plagued by academic, social and economic problems detrimental to their educational progress cannot be addressed without well-trained teachers. Such teachers understand how to meet the diverse needs of students with varying learning styles, family situations, and expectations about themselves and the education they attain. Inner city students are also often in dire need of role models and mentors capable of extending guidance and support to sustain these students in the world beyond the classroom. Strengthening teaching thus necessitates stronger preparation, selection and inclusion practices.

Current educational reformers echo past criticisms that schools provide most children with an education that is too rigid, too passive, and too rote-oriented to produce learners with

higher-order thinking skills. The history of U.S. education verifies that contemporary reforms, such as the child-centered approach focusing on the needs and aptitudes of students, the thinking curriculum aimed at higher order performances and cognitive skills, team teaching, cooperative learning, student-centered instruction, and authentic assessment, actually originated in earlier decades [10]. These efforts, aimed to promote quality, equality, access and equity in education, were defeated because qualified teacher recruits could not be trained in sufficient numbers [11].

In the past, learner-centered education tended to give way to influences that lowered curriculum standards; the cycle began again when renewed criticisms of schools engendered more attempts to restructure them. Research indicates that current efforts at school reform are likely to succeed to the extent that they are built on a strong foundation of teaching knowledge and are sustained by a commitment to structural rather than merely symbolic change [12]. Major changes in the productivity of all American schools, particularly those in inner cities, are thus likely to depend on our ability to create and sustain a highly-prepared teaching force including teachers from underrepresented populations – qualified teachers for all, not just some, of our children. ■

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